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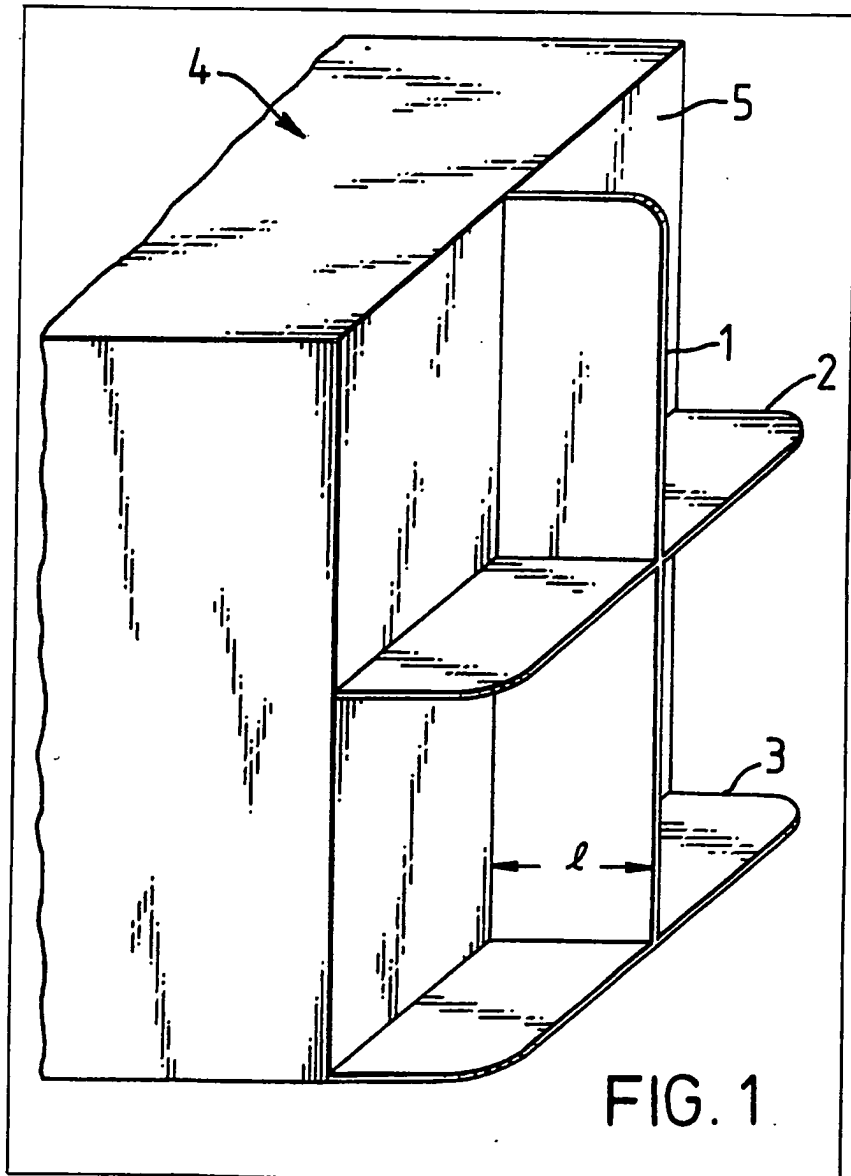
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(54) **Drag reduction in road vehicles**

(57) A tractor-trailer vehicle is provided with fixed horizontal and vertical plates 1, 2, 3 extending forwardly from the trailer front 5. The plates define relatively small volumes

in the tractor-trailer gap space in which controlled vortex flow is established, which reduces total vehicle drag. Flow on the trailer roof is improved by a removable streamlining device, preferably inflated to the desired shape.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

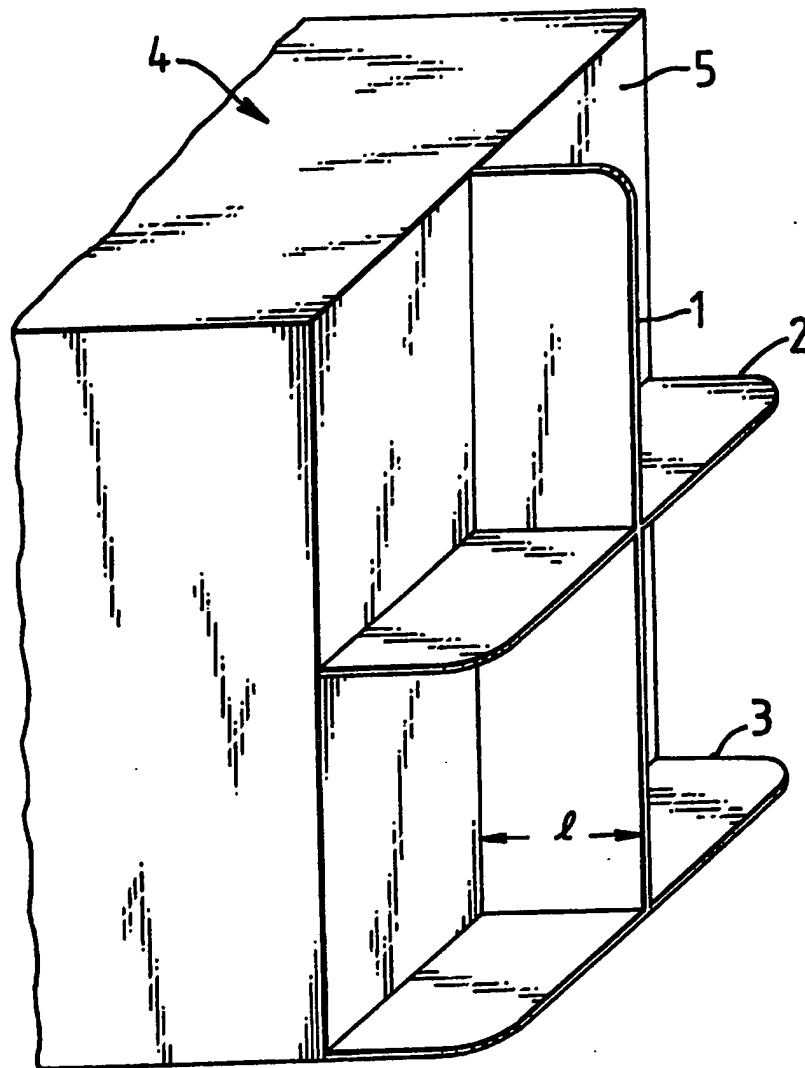


FIG. 1

2 / 2

FIG. 2

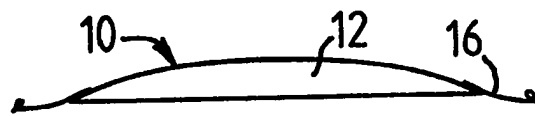
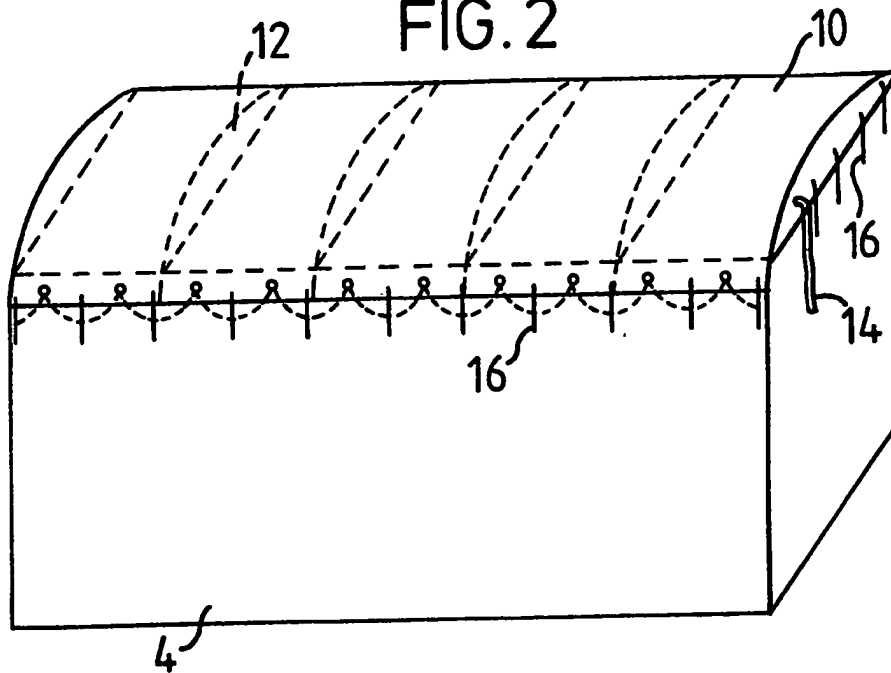


FIG. 2a

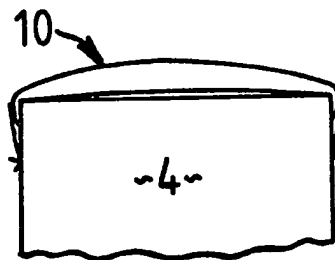


FIG. 2b

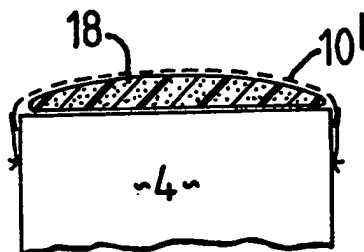


FIG. 2c

# **SPECIFICATION** **Drag reduction in road vehicles**

This application relates to means for reducing drag in road vehicles, particularly tractor-trailer articulated vehicles.

Our patent application No. 8036403 discusses the problems involved in reducing drag in such vehicles, and discloses various means of achieving drag reduction. As discussed in that application, many prior art approaches to this problem have been deficient in dealing essentially with vehicle movement through still air with the relative airflow impinging on the front of the vehicle, whereas in practice side winds frequently produce a yaw condition in which prior art devices are ineffective.

The present application is concerned with two means of drag reduction which have utility in yaw conditions.

In one aspect, the present application is concerned with plate devices positioned in the tractor-trailer gap space, as broadly disclosed and claimed in our application No. 8036403. According to this aspect of the present invention provides, in a tractor-trailer combination having a gap space, drag reducing means comprising plate members secured to the front face of the trailer and extending substantially normally therefrom into the gap space, the plate members comprising at least one vertical plate and at least two horizontal plates, the horizontal plates being spaced apart. Preferably, the vertical plate is on the longitudinal centre line of the vehicle, the upper horizontal plate is level with the tractor roof, and the lower horizontal plate is at the foot of the trailer body.

The effect of this plate system is to stabilise flow in the gap space region by encouraging the formation of controlled standing vortices.

In another aspect, the present application is concerned with the trailer roof area. In yaw conditions there is a tendency to flow separation and the formation along the windward edge of the roof, and also irregular flow separation around the leeward edge. The invention accordingly provides a drag-reducing device for attachment to the roof of a box-shaped goods vehicle, the device comprising a sheet adapted to be attached to the vehicle to cover the roof and to extend around at least the longitudinal edges of the roof, and means for distending the sheet into a rounded condition. In one form, said sheet is the upper surface of a bag, and said means resides in the bag being inflatable. Alternatively, a filling of soft foam material may be used for distending the sheet. The sheet may be provided with ropes at its edges for attachment to cleats or the like on the vehicle walls.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:—

Fig. 1 is a diagrammatic perspective view of the fore part of an articulated vehicle trailer, having a plate system in accordance with the invention;

Fig. 2 is a diagrammatic perspective view of a trailer or truck body with a rooftop device according to the invention;

Fig. 2a is a cross-section of the device before being applied;

Fig. 2b is a cross-section of the device in use; and

Fig. 2c is a cross-section of a modified device.

Referring to Fig. 1, a box-type trailer body indicated at 4 is provided on its front face 5 with a central vertical plate 1, an upper horizontal plate 2, and a lower horizontal plate 3. The plates are rigidly secured to the front face 5 in any convenient manner, and extend perpendicularly to it. The forward dimension *l* is as large as possible towards the rear of the tractor (not shown) within the geometry of the tractor-trailer combination. The corners of the horizontal plates 2, 3 are rounded as shown to facilitate turning of the vehicle.

It is preferred to have the lower horizontal plate 3 level with the bottom of the trailer body 4. The upper horizontal plate 2 is suitably level with the cab roof.

The effect of the plate system is to divide the gap space into distinct volumes in which standing vortices are set up, and turbulence in the gap space is controlled. This is particularly beneficial in yaw conditions. If necessary, smaller volumes can be provided by increasing the number of plates.

For example, two vertical plates equispaced on the trailer front may be suitable.

Referring now to Fig. 2, there is illustrated a device for attachment to the trailer roof. In Fig. 2a, this takes the form of a bag 10 which can be inflated via a hose 14. The bag 10 has a width larger than that of the trailer so that it can wrap round the longitudinal and the front and rear edges of the trailer roof when attached in position. Its cross-sectional shape is maintained by internal supporting ribs 12 placed at intervals along the longitudinal direction. When placed over the trailer roof, the bag 10 extends from the tail end to the front end of the trailer. Side ropes 16 tie the device down at intervals and secure it in position before the bag 10 is inflated. The shape of the inflated bag will bulge as shown in Fig. 2b, and provides rounded corners along the edges and a rounded roof over the trailer. The maximum depth of bag 10 measured from the trailer roof will be about 10% of the height. The rounded edges and the round roof together will improve the flow conditions a great deal. The side flow component in particular now follows more closely the contour of the device for without the device, the flow will definitely separate from the windward edges and create large scale eddies. The flow will still separate towards the leeward edges, but it will become much more steady. Moreover, the wake size beyond the trailer will be very much reduced. The result of this is a substantial reduction of drag in yaw conditions.

The advantages of the inflatable device are several. It is simple to manufacture and easy to erect for it requires only rope attachments to the

existing vehicles. It is therefore inexpensive and requires no special skill for fixing it to the vehicle. It can be folded up to a much small volume when not in use. The compressed air supply for inflating the device is usually available at transport depots.

Instead of being inflatable, the bag may be filled with foam. In an alternative form illustrated in Fig. 2c the bag 10 is replaced by a flexible sheet 10' which is stretched over a foam pad 18.

- 10 The device can be extended to cover the front face of the trailer in exactly the same manner. When erected, the device will provide a bulged front, two rounded vertical edges and a fairly large rounded edge at the upper front position of the trailer in addition to those features already described. This arrangement is particularly useful in calm air as well as in yaw conditions. In calm air, the head-on wind will be able to flow round the upper corner of the trailer with much smaller disturbances and it allows a smaller size add-on device to sit on the cab roof, hence a smaller drag on the tractor. In yaw, a rounded frontal face is exceptionally useful to guide the flow round the trailer. Appreciable drag reduction has been found to achieve in this arrangement for various yaw angles. A flow visualisation has indicated that the airflow round the trailer has become much more steady.

- 30 In the case where there are fixtures on the trailer's frontal face, the device can be specially arranged to accommodate them. For convenience, the device need only be extended a short distance

to the front face of the trailer so as to produce a rounded edge.

### 35 CLAIMS

1. A drag reducing means in a tractor-trailer combination having a gap space, comprising plate members secured to the front face of the trailer and extending substantially normally therefrom into the gap space, the plate members comprising at least one vertical plate and at least two horizontal plates, the horizontal plates being spaced apart.
2. The drag reducing means of claim 1, in which the upper horizontal plate is substantially level with the tractor roof, and the lower horizontal plate is at the foot of the trailer body.
3. The drag reducing means of claim 1 or claim 2, in which a single vertical plate is positioned centrally of the trailer.
4. The drag reducing means of claim 1 or claim 2, in which a plurality of vertical plates are equispaced across the front of the trailer.
5. A drag reducing device for attachment to the roof of a box-shaped good vehicle, the device comprising a sheet adapted to be attached to the vehicle to cover the roof and extend around at least the longitudinal edges of the roof, and means for distending the sheet into a rounded condition.
6. The device of claim 5, in which said sheet is the upper surface of a bag, and said means resides in the bag being inflatable.
7. The device of claim 5, in which the sheet is distended by a filling of foam material.